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ABSTRACT

Designed to isolate curriculum needs for computer education courses for preservice and inservice elementary school teachers, this study identified patterns of microcomputer use as they have been planned and implemented in elementary classrooms together with factors that affect those patterns. The cluster analysis procedure was used to analyze interview, classroom observation, and questionnaire data on classroom microcomputer use obtained from 29 randomly-selected kindergarten through grade six teachers. Characteristics of classroom microcomputer use patterns are identified within two frameworks. The first is a typology developed by Shavelson which distinguishes among orchestration, adjunct instruction, enrichment, and drill and practice; the second is an adapted list of curriculum elements originally described by Goodland, Klein, and Tye, which focus on goals and objectives, subject matter, activities, teaching strategies, evaluation, grouping, time, and space. Five areas of confusion about computer use in the classroom were identified through a qualitative analysis of case records: (1) process vs. product; (2) entertainment vs. motivation; (3) what constitutes ethical use of time; (4) curriculum integration; and (5) student accountability. These are briefly discussed and their implications for both preservice and inservice teacher education are described. (10 references) (GL)

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FACTORS AFFECTING USE OF COMPUTERS IN ELEMENTARY CLASSROOMS: IMPLICATIONS FOR PRESERVICE AND INSERVICE EDUCATION

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Visit a classroom with a microcomputer in it. You may see a work station with two students busily editing a story or entering data into a database. Or you may see the computer sitting on a corner table with the plug dangling freely underneath. Between 1981 and 1987, the Office of Technology Assessment determined that the percentage of schools with one or more computers designated for instructional use has increased from approximately 18 percent to 95 percent (1988). The ratio of students to computers has increased from 92.3 students per computer in 1983 to 30.8 students per computer in 1988 (OTA,1988).

Disparity exists however between the current flood of computers into schools and the ability of teachers to use them effectively. Only one-third of all K-12 teachers have had as much as 10 hours of computer training, most of which concerned learning about computers, not learning how to teach with computers(OTA, 1988). State requirements for preservice education , in the past, have also been minimal. However, state requirements for both preservice and inservice education in the use of computers is growing. In 1987, 18 states required computer education for preservice education while 3 states required computer education for inservice teachers (OTA, 1988). By 1988, 24 states required all or some students in teaching degree programs to take computer courses in order to be certificated. Additionally, in 1988 11 states required computer education for inservice teachers (Bruder, 1988).

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The objectives of the study reported in this paper were to identify patterns of microcomputer use as they have been planned and implemented in elementary classrooms, and to identify factors which affect those patterns in an effort to isolate curriculum needs for computer education courses.

CONCEPTUAL FRAMEWORK

Successful use of computers in classrooms requires complicated planning by teachers as they structure the curriculum for their students and engage in the teaching of that curriculum. Research therefore must be based on the teacher planning and decision-making paradigm in which teachers' thought processes, including planning, interactive thoughts, decisions, theories and beliefs interact with teachers' actions and their observable effects. Those effects include teachers' classroom behavior, students' classroom behavior and student achievement. The resulting process is what actually takes place in the classroom (Clark and Peterson, 1985).

A study conducted by Shavelson & Others (1984) examined patterns of microcomputer use among teachers nominated as having developed successful mathematics and science microcomputer programs in elementary and secondary classrooms. That study investigated teachers' plans for incorporating microcomputers in the ongoing curriculum.The Shavelson, et.al. study identified variables based on a definition of curriculum in which goals, objectives, subject matter, and course materials were the elements which would define the range of activities in which microcomputers were integrated. Results from that study indicated that

there were four general patterns of use. These included: orchestration, adjunct instruction, enrichment, and drill and practice.

Curriculum integration in the multisubject self-contained elementary classroom is complex and is a result of teacher planning and decison making. Curriculum integration has been defined as the horizontal relationship of curriculum fields to each other, such as the utilization of what is read in literature during the study of history (Tyler, 1949, p.85). Taba described curriculum integration as the use of integrative threads to facilitate the learner's understanding of knowledge and/or ability to organize learning experiences. This concept of integration changes the emphasis from subjects to ideas, problems, or methods that are unified by two or more learning experiences (Taba, 1962, p.299). According to Taba, an assessment of integration would need to include examination of (a) how well different subjects had been integrated and (b) how well learning experiences and materials had been organized to enhance the learning of subject matter.

Curriculum integration goes beyond the incorporation of instructional tools in the curriculum. For example, one could use the computer, the textbook, and fraction kits to teach three different groups of students the same concept in mathematics; yet this may not reflect curriculum integration. The concept of integration involves the linking of subject fields and/or learning objectives. Integration necessitates knowledge of content and process. Planning for integration requires sorting out of the varied disciplines and selecting and translating academic concepts into concepts for teaching elementary students.

Integration of computer-based instruction with the curriculum in the elemetary level classroom should therefore include integration across

subjects of content, concepts and skills; integration with activities; integration with teaching and grouping strategies; integration of time factors; and integration with the management system used to organize the classroom. Curriculum integration variables were defined and examined in this study to determine their relationship to the microcomputer-based instruction planned by teachers.

Research has identified the ability of the classroom teacher to manage the social system in the classroom as contributing heavily to the successful implementation of curriculum plans (Doyle, 1985). Adding microcomputer use to the elementary classroom imposes an additional activity segment which the teacher must include in the management structure. Therefore, this study included examination of the relationship between the teachers' ability to manage the classroom and patterns of microcomputer-based instruction planned and implemented by the teachers.

The study reported in this paper was designed to determine if those same patterns existed in the general population of elementary level teachers using computer-based instruction for all subjects, in addition to any possible alternative patterns. In an effort to identify specific factors that might affect how teachers chose to include the microcomputer in their programs, this study expanded the definition of successful classroom computer use postulated by Shavelson, et.al.(1984) to include nine curriculum elements identified by Goodlad, Klein and Tye (1979) (goals and objectives, materials, content, learning activities, teaching trategies, evaluation, grouping, time, and space). In addition, a more elaborate definition of integration in the self-contained elementary classroom was used (See Table 1). Variables for study were then identified on the basis of this definition of classroom computer use.

Table 1

Elements of Classroom Computer Use

INSTRUCTIONAL GOALS
- (a) Achievement*
  1. Mastery of basic skills/procedures*
  2. Acquisition of subject-matter concepts*
  3. Acquisition of computer literacy skills
- (b) Motivation*
- (c) Social*

ONGOING CURRICULUM
- (a) Subject matter*
- (b) Course materials*
- (c) Learning activities
- (d) Teaching strategies
- (e) Evaluation
- (f) Grouping
- (g) Time
- (h) Space

COMPUTER-BASED LEARNING ACTIVITIES
- (a) Modes of computer use
  1. Drill and practice*
  2. Tutorial*
  3. Simulation*
  4. Microworlds*
  5. Games*
  6. Word processing
  7. Database
  8. Spreadsheets
- (b) Grouping of students*
- (c) Time allocation among students for computer use*

APPROPRIATENESS OF INTEGRATION
- (a) Contribution of computer use for insructional goals*
- (b) Coordination between the curriculum and computer use
  1. Content match*
  2. Integration of subject areas
  3. Integration of time
  4. Coordination of teaching strategies with computer use
- (c) Strategies for assigning students to computer activities*

FEEDBACK
- (a) Evaluation of student progress*
- (b) Use of CMI for management*
- (c) Changes in computer-based activities*

*Elements identified in the Shavelson et al. (1984) study

METHOD

Data Samples

Data were obtained from 29 classroom teachers, representing grades kindergarten through grade six, from five schools in three metropolitan school districts. Each district was selected on the basis of not having yet developed any type of continuum of microcomputer-related skills or instruction which would have resulted in teachers at specific grade levels being required to incorporate a specific type of microcomputer instruction into the curriculum. As a result, each participating teacher had complete freedom to determine how microcomputer-based instruction would be used in his/her classroom. Teachers were chosen randomly from among those who volunteered to participate. Representation from grade levels was evenly mixed.

Data Collection

Each teacher participated in a 45 minute taped interview, had his/her classroom observed for two 30 minute periods during which microcomputers were in use, and completed a questionnaire. One observation took place prior to the interview, while a second took place following the interview. An observation guide and interview guide were used in addition to the questionnaire. Field notes were also written immediately following each observation. Data was transcribed to case records and translated to codes defining variables which could be used for statistical analysis.

RESULTS

Data Analysis

Data analysis initially followed that used in the Shavelson, et.al study in an effort to replicate patterns of use identified as a result of that study. Sixteen variables, identified by Shavelson, et.al defined the successful integration of microcomputer-based instruction with the ongoing curriculum were used to perform heirarchical clustering analysis. Six primary variables were used to establish clusters while the remaining variables were used to further define the clusters found.

In the present study, differing results for cluster membership were found by applying different clustering methods, therefore, twelve of the original sixteen variables which had been found to have statistically significant differences between clusters were used for the complete analysis to make results more valid. Four clusters were identified. Additional variables were examined by applying one-way analysis of variance to the clusters. Findings indicated that grade level might be a highly significant factor in cluster identification. Therefore, clusters were reexamined by grade level membership. Results indicated that the identified clusters were related to grade level membership with Cluster 1 containing upper grade orchestrators, Cluster 3 containing primary grade orchestrators, and Clusters 2 and 4 having some siginificant differences between upper grade and lower grade members.

Characteristics of Patterns

Cluster 1 was labeled "Upper Grade Orchestration" and was similar to the cluster identified by Shavelson, et.al. as "Orchestration". These

teachers used microcomputer-based instruction to accomplish primarily cognitive goals, used the computer successfully for instruction in many subjects by integrating its use well with elements of the ongoing curriculum. Upper Grade Orchestrators coordinated computer-based instruction with regular class activities, used more teaching and grouping strategies than teachers in Clusters 2 and 4, and required student accountability for microcomputer-based instruction. The Upper Grade Orchestrators used a high number of instructional modes, grouped students in pairs for instruction, and provided a great amount of student computer time. This group used microcomputer-based instruction to integrate content, skills and concepts from various subject areas. They sometimes integrated computer-based instruction with the time schedule for study of other subjects and occasionally allowed students to complete computer-based instruction during large group recitation lessons.

Cluster 3 was labeled "Primary Grade Orchestration". These teachers emphasized mastery of basic skills as a goal and used computer-based instruction primarily in reading, math and language arts. The Primary Grade Orchestrators grouped students for individual instruction, using a high number of modes. All used drill and practice and word processing. This group usually coordinated computer use with other activities, integrated computer use with subject matter time schedule, never scheduled students for computer use during large group recitation lessons, required student accountability for computer work, and changed their computer program based on feedback. The Primary Grade Orchestrators perceived their program as being highly integrated with the curriculum and highly successful, and their programs were rated as highly integrated and successful.

Cluster 2 was labeled "Enrichment". The Enrichment teachers appeared to use computer-based instruction to enrich the regular program, but had not fully integrated computer use with the curriculum. These teachers did not emphasize cognitive or mastery of basic skills, but did consider introduction to the technology a goal . The Enrichment teachers used microcomputer -based instruction primarily in Reading and Mathematics, using fewer instructional modes than teachers in Clusters 1 and 3. Membership was differentiated by grade level with primary teachers using drill and practice extensively and upper grade teachers using word processing. The Enrichment teachers coordinated computer-based instruction with other activities less than teachers in Cluster 1. These teachers used fewer grouping and teaching strategies than teachers in Cluster 1. They did not require student accountability for computer work. Students were grouped in pairs, usually by ability, with upper grade teachers sometimes grouping by computer knowledge. Student time at computers was significantly less than for students in Cluster 1. The Enrichment teachers did not integrate microcomputer-based instruction by applying subject matter content or concepts across subjects. They seldom scheduled computer time during large group recitation lessons. They occasionally changed their computer program based on student feedback. The Enrichment teachers did not perceive their program to be highly integrated, and received lower integration and success ratings than teachers in Clusters 1 and 3.

Cluster 4 was labeled "Limited Introduction" . Teachers in this cluster placed a limited amount of emphasis on using microcomputer-based instruction for instruction and had not integrated its use with the ongoing curriculum. In fact, these teachers perceived the level of integration and

successfulness of computer-based instruction as low. The Limited Introduction teachers used the computers primarily in Reading and Mathematics, using primarily drill and practice courseware which was often not coordinated with any instruction in the regular curriculum. They did not require student accountability for work completed at the computer and did not change computer-based instruction. In addition, students in this cluster spent the least amount of time engaged in microcomputer-based instruction

Patterns of Use and the Curriculum

Results from the data analysis were also used to investigate the relationship between patterns of microcomputer use and the ongoing curriculum.

Goals and objectives were related to patterns of use with Upper Grade Orchestration emphasizing cognitive goals, Primary Grade Orchestration emphasizing mastery of basic skills goals and the Limited Introduction teachers being the only ones who did not view use of the microcomputer for the purpose of introducing students to the technology as a goal.

Subject matter differences were also identified. Computers were most frequently used for instruction in mathematics. All Upper Grade Orchestration teachers used the computer in Language Arts while all the Primary Grade Orchestration teachers used the computer for Reading. In addition, the Upper Grade Orchestration teachers used the computer for instruction in science and social studies, while other patterns of use usually did not. Computers were not used for music or art instruction.

Coordination of activities and microcomputer use was attempted by most teachers, with the Upper Grade Orchestration teachers achieving the highest degree of coordination.

The number of observed teaching strategies differed among patterns of use with the Upper Grade Orchestration teachers using more teaching strategies than other patterns. Very few teachers allowed students to engage in microcomputer-based instruction while the large group recitation strategy was being used.

Evaluation, measured in terms of student accountability, was included as part of the computer-based instruction program for teachers who were in the Upper Grade or Primary Grade Orchestration patterns. Other patterns of use did not require student accountability.

Grouping was examined from two directions: how teachers grouped the class, and how teachers grouped students for work on the computers. There were differences among patterns of use for the number of grouping strategies observed. Upper Grade Orchestration teachers used significantly more grouping strategies than teachers in other patterns. Teachers also grouped students for computer instruction according to patterns of use. The Upper Grade Orchestration teachers and the Enrichment teachers alsways grouped students in pairs, while the Primary Grade Orchestration teachers grouped students individually. The Limited Introduction teachers sometimes grouped students in pairs.

Time was another curriculum element which varied among the patterns of use. The Upper Grade Orchestration teachers provided students with the greatest amount of time at the computers. The Primary Grade Orchestration teachers integrated the subject matter content of computer-

based instruction closely with the time scheduled for regular instruction in the same subject area.

Finally, the curriculum element of space was investigated by examining the location of the microcomputer and possible effects it might have on any other activities. No differences were found among patterns of use regarding the location of the computer.

Patterns of Use and Curriculum Integration

Measures of curriculum integration revealed only a few differences. The Upper Grade Orchestration teachers integrated microcomputer-based instruction across subject areas to a limited degree. Teachers sometimes integrated computer-based instruction with the time schedule for regular subject instruction and rarely scheduled computer-based instruction simultaneously with large group recitation lessons. Overall integration of microcomputer-based instruction with the ongoing curriculum was related to pattern membership, with the Upper Grade and Primary Grade Orchestrators perceiving their programs as being more integrated than teachers in the other patterns. In addition, their programs were rated as more integrated than teachers in the other two patterns.

Patterns of Use and Classroom Management

The relationship between patterns of use and classroom management was investigated by rating teachers during observations on their classroom management ability. While results were not statistically significant, it appeared that the Upper Grade Orchestration teachers, and to some extent, the Primary Grade Orchestration teachers, were more effective at

managing the classroom social system than teachers in the other two patterns.

Levels of Success

The four patterns identified in this study appear to represent definite levels of microcomputer use ranging from a limted and rather poorly integrated level of use to a highly organized and integrated level of use. Taking the position that every educational experience planned for students must make optimal use of the time students spend engaged in curriculum related activities, these levels of use can, and should be, described in terms of levels of success. Those teachers in the Limited Introduction pattern of use had not been very successful at linking microcomputer0based instruction with the regular curriculum, resulting in little, if any, improvement in the overall instructional program. Teachers in the Enrichment pattern appeared to have been more successful, but had still not achieved what would be considered to be an optimal level of integration with the regular curriculum. Meanwhile, those teachers in the Primary Grade Orchestration and Upper Grade Orchestration patterns had been more successful at mixing microcomputer-based instruction with elements of the ongoing curriculum. Analysis of differences that existed between these patterns of use should be helpful in directing teachers toward achieving more successful integration of microcomputer-based instruction in their curriculum.

IMPLICATIONS FOR PRESERVICE AND INSERVICE EDUCATION

Beginning with the premise that an effective teacher uses the computer as an instructional tool to facilitate the delivery of content and as an

integral part of the process of education, implications are concerned with the professional understandings needed by teachers. The word "professional" is used purposefully in contrast to the much used "training" in the use of technology. The point being that learning how to operate a computer may require miniscule training in order for teachers to be familiar with the actual procedures for operating a computer. But unfortunately, preparation for utilizing the computer effectively in the ongoing classroom instructional program requires concerted effort and understanding about both curriculum and instruction.

The Use of the Computer in the Classroom: Typical Confusions

Following the identification of patterns of use, qualitative analysis of the case records of pattern members was made in an attempt to examine differences among the patterns. Inspection of classroom observation notes, teacher interviews, questionnaires and field notes resulted in the identification of the following confusions about computer use in the classroom.

Confusion #1: Process vs. Product

Is computer use the goal to be valued, or is the computer-based activity the means to learn subject matter? Computer use can be confused between process and product when the computer is not regarded as an instructional tool for teaching specific content related to the ongoing curriculum. The computer, like other instructional tools, should extend the process of instruction. When the tool is not exploited for its range of applications, and software is not explored for appropriateness, teaching how to use the microcomputer becomes a very limited and narrow goal.

For example, during the interview, teachers were asked about their goals for including a microcomputer in their program. Many teachers in the Enrichment pattern reported that their primary goal was to have students master basic skills but that a secondary goal was to give the students the opportunity to experience working with a computer. Through further questioning and subsequent observation, however, it became evident that they valued the goal of having the students interact with the computer enough to allow circumvention of the previously stated primary goal of mastery of basic skills. This resulted in students often being sent to the computer to use a program which reviewed a skill the student did not need to master. A typical teacher response was that this was acceptable because the student was getting the opportunity to use the computer.

Confusion #2: Entertainment vs. Motivation

Confusion between entertainment and motivation sometimes blurs instructional planning. The selection of appropriate learning activities and instructional tools and/or materials that 1) fit the instructional goal and 2) are of high involvement and interest for the learner seems to be particularly difficult. The computer is used to entertain instead of educate.

Two different manifestations of this confusion were observed. In the first, teachers allowed their selection of courseware to be guided by their desire to provide a motivating classroom environment. For example, in one classroom students were observed going to the computer during reading to use Face Maker, a program in which students selected various face parts to construct "silly" faces. The teacher reported choosing the program for "motivation purposes". In the second, a few teachers used

the computer as a reward for finishing assignments early. They reported that they did this as a motivation technique. Not coincidentally, most of the courseware observed in these classrooms was in a game format.

Confusion #3: Concerning the Ethical Use of Time

Confusion concerning the ethical use of time affects computer applications in the elementary classroom. When weaving the use of the computer into the regular instructional program, teachers must make decisions which ultimately affect how a student's time is spent in the classroom. If it is math time and all students cannot use the computer for mathematical purposes during "math time", should some students continue to use the computer during "science time" for studying and practicing mathematics? Will those students who are using the computer miss out on what is being taught about science? For example, in one classroom the teacher used the computer only for providing drill and practice in science by using a program provided by the textbook publisher which drilled the students on information contained in the textbook. She had scheduled the students to go to the computer in pairs each day for 10 minutes. The same schedule was repeated every day. An observation of her classroom took place during "math time". While she worked with one math group, other students were completing independent work. Two pairs of students working independently were scheduled to go to the computer. Transition time to and from the computer (representing the amount of time the students were observed off-task at their desks prior to and following the scheduled computer time) was approximately six minutes for each student. Combined with the ten minute computer activity, that amounted to sixteen minutes of allocated math time missed every day by those particular

students . For any given week, those students were involved in math related activities eighty minutes less than their classmates.

A related confusion concerning the use of time involved the issue of equal access. Several teachers were observed requiring all students to complete a specific program for a given subject, or scheduling all students to use the computer for a given subject, ostensibly in consideration of providing equal access to the technology. What was not considered was that all students did not need to have the same experience in the same subject using the computer. As a result of this confusion, the computer was not viewed as an instructional tool which could provide individualized help for specific skills.

Confusion #4: Curriculum Integration

Confusion exists concerning the curriculum integration possible in the elementary classroom and integration of the microcomputer with some component of the curriculum. For many of the teachers interviewed in the study, it was apparent that their planning for curriculum integration of the microcomputer tended to reflect a limited working definition of curriculum integration in which they used the microcomputer to reinforce a specific objective in a given subject area. Because they had previously taught the concept being reviewed, they perceived their use of the microcomputer to be well-integrated. In addition, some teachers perceived their microcomputer use to be well-integrated because they used the computer in two or more subject areas.

Confusion #5: Student Accoutability

Because the computer has the ability to monitor student progress and provide immediate feedback, it is assumed that student accountability for

work completed at the computer need not be administrated by the teacher. Much of the courseware used was drill and practice which always gave students immediate feedback and usually reported a score at the end of a segment. While a few of the programs saved the score for the teacher in a data bank, most did not. For those programs that did not save scores, teachers rarely required students to write down their scores for teacher inspection, stating that they felt the computer's ability to give feedback provided an acceptable level of accountability.

Helping the Preservice Teacher

College level courses for the preservice teacher in the past have focused on developing the students' computer literacy or knowledge of programming (OTA, 1988). Currently, the number of states requiring preservice computer education is growing and that trend will probably continue. Results of the study reported here suggest that computer education for the preservice teacher must go beyond computer literacy or programming to focus on curriculum integration of the microcomputer into the traditional school curriculum.

The Methods Class

In addition to taking a course in computer education which will familiarize the student with basic operations, terminology and use of hardware, software and system components, integrating the computer into the curriculum requires much skill. Using the computer for instructional purposes needs to be part of the preservice teacher's methods class. The beginning teacher should use the computer for personal planning in

addition to learning how to use it as an instructional tool to be integrated as part of the curriculum . To facilitate understanding of computer applications, the preservice teacher should be encouraged to use the computer for lesson planning (word processing), storing of lessons (data retrieval), and keeping grades (spread sheets). Use of the computer should be included in unit planning as an instructional tool for achieving learning objectives. Emphasis should be on use of the computer as a means of achieving an objective.

The computer should be studied as part of the instructional process. Some preservice programs help the novice teacher learn models of teaching. At the University of Southern California student teachers learn four theory based models: group investigation, concept attainment, advance organizer, and direct instruction. The students need to explore how to use the computer as an instructional tool in these varied teaching models. For example, the students need to consider how the computer might be used for constructing a database during group investigation. In contrast, use of the computer as part of the direct instruction model might take place during independent practice to accomodate various ability levels. The preservice teacher needs to consider the relationship between various instructional strategies and microcomputer use.

Classroom Managment

During the student teaching experience the novice teacher should practice classroom management of the computer for individual student work, tutoring, and group work. The classroom computer should be treated as a learning center and the inexperienced teacher should learn how to introduce activities at the computer center to students and change

the center's application for a variety of instructional objectives. As a learning center the computer should be used by varied groups of children in different subject fields and at different times of the day. As a learning center, the student teacher will also need to plan for access to and from the center, giving consideration to traffic patterns and transition routines.

Planning for evaluation will be important. How will students' use be monitored? Will feedback occur through the computer program or will it be dependent upon the teacher? Will success be measured as a product, such as writing a story?

The preservice teacher needs to consider a variety of criteria for grouping students to use the computer. Much will depend on the computer appplication. The beginning teacher needs to practice planning computer use for basic skill instruction, the development of writing skills, problem solving, learning abstract concepts, simulations, and database management. In addition, age and computer ability of the students may be important.

Since most preservice programs require that the student teacher experience two different grade levels, the novice teacher should have the opportunity to observe and practice computer applications and evaluate differences related to students' ages, abilities, and content.

Time Management

The beginning teacher has difficulty planning and managing time both during a single time slot and over the course of the day, week, or semester. Time management requires value choices. When should specific content (subject fields) be taught and what learning experiences should be featured? Does the teacher continue a given lesson beyond its customary time slot when a)students are learning, b) involvement is high, c) all

students have not had an opportunity to use materials of instruction, d) reteaching is necessary? Judgement about the use of time develops as the novice teacher learns content and pacing and can judge overlearning, busyness, and involvement.

Since the typical classroom has but one computer for thirty students (OTA, 1988), student time on the computer needs to be carefully considered both for what is to be learned or gained through computer use and what is to be learned or gained through other instructional means during the same time slot. In consideration of individual or group use of the computer the teacher needs to think about what other student groups will be doing.

If the teacher plans to do direct instruction of a skill or new concept to themajority of the class, how will the students working at the computer gain the same new skill or concept? (Will computer time contribute to lost or waste time for the student?) It is these considerations which involve a unitary period of time that necessitate integrative planning.

Curriculum Integration

The preservice elementary teacher has difficulty sorting out the varied disciplines and selecting and translating academic concepts into concepts for teaching elementary students. Sometimes there is a lack of understanding of each of the disciplines and the processes peculiar to the discipline. Learning to plan by "units" or "themes" is essential for the interdisciplinary teaching that occurs in elementary classrooms. Learning to include the computer appropriately as an instructional tool for teaching the unit will take considerable practice.

Helping the Inservice Teacher

Teacher inservice in the use of technology is growing and studies have been conducted to determine how that inservice could be best delivered (OTA, 1988). The recommendations discussed here will not be concerned with the stages through which computer inservice should progress (i.e. an "awareness" level to help teachers overcome anxiety), but will discuss skills teachers may need to learn and planning decisions teachers will need to incorporate as they try to integrate computer use into the ongoing curriculum.

Let us assume that the experienced teacher understands curriculum content and may be somewhat knowledgeable about the integration of content, skills, and learning experiences. Let us also assume that the experienced teacher is motivated to use the computer in the classroom.

What the experienced teacher may lack is knowledge and practice using a variety of teaching models and knowledge about the infusion of computers as an instructional tool. This sounds relatively simple; yet it is not. Using the computer in the classroom requires **NEW** teaching skills. This probably means that the teacher needs to see the computer in use, needs opportunity to practice using the computer for instruction, needs feedback and coaching while using the computer for instruction and considerable time to adapt the computer as an instructional tool in different subjects and in different contexts.

Classroom Management

Using the computer as an instructional tool emphasizes the instructional management decisions of teachers. The computer is more than a pencil, textbook, overhead projector or laboratory experience. The teacher needs

to learn when to help students and in what ways to help them. Learning how to monitor students' computer use, how to provide feedback, and how to determine student accountability will require time and practice.

First, the teacher needs to decide where to house the computer and peripherals. Classroom traffic patterns need to be *considered. Unlike* other instructional centers, this one cannot be moved around easily. Sound on particular programs and printer noise can be distracting. Physical limitations such as glare on the monitor screen and the potential for chalk dust to ruin disks must be considered.

Rules and standards will be unique. Students need to know what to do if they have difficulty operating the hardware. Students will often need assistance with operation of software, particularly applications such as word processing. It is imperative that the teacher construct a system which frees him/her from having to continually provide assistance. Usually, peer tutors are used, but additional rules and standards are then needed to successfully manage their use.

Consideration needs to be given to how many students will use the computer at one time. Will students be grouped by academic ability level, computer ability level, or interests? At what times is it more effective to have students work alone at the computer?

Teachers need to consider how software will be introduced to the students. The teacher may need to learn how to use the computer with a large monitor and work with the entire class at one time. It may also seem more manageable to the teacher to train a small cadre of peer tutors to use a given piece of software and have them systematically teach the other students.

Teachers need to give careful consideration to evaluation of student progress through student accountability. An accountability system needs to be developed in which the teacher communicates to the students the value placed on their computer related assignments. Teachers need to consider that different computer applications may require different accountability systems. Finally, teachers need to carefully analyze the system they develop to insure that it minimizes rather than impacts the monitoring they must engage in during classroom instructional time.

Selecting Software

Unlike textbooks that are usually graded, software needs to be previewed and considered in terms of students' ability levels, students' interests, subject matter applications, and varied learning objectives. Teachers need to carefully consider which learning objectives will be met by using any given software program. Teachers need to analyze how the process/product and entertainment/motivation confusions develop so they can be avoided.

Teachers need to be given assistance in learning how to incorporate the use of application tools such as word processing and database in their programs. Because these are tools, teachers will be required to construct lessons which incorporate their use. For the inexperienced computer user, this represents a marked contrast from commercially prepared drill and practice, games, tutorials, or simulations.

Time Management

Using the computer for one, two, or more students requires thinking about what the students at the computer will be learning and what all other students will be learning at the same time. Teachers need to seriously consider how the schedule they construct impacts the allocated learning time for students in different subject areas.

Alternative scheduling plans should be considered for each piece of software chosen for use. While a drill and practice program may require ten minutes for the student to complete, word processing a story may require thirty minutes. Teachers need to develop a schedule which can accomodate these differences.

Models of Teaching

More than other instructional tools, the computer begs to be used in a variety of teaching strategies. The computer cannot be used as a database unless the teacher emphasizes problem solving and inquiry. Since the whole class cannot use the computer at the same tame for database investigations, the teacher needs to plan a variety of instructional materials and consider grouping and cooperative learning. Similarly, using the computer for simulations requires learning to use this strategy effectively. Each of the instructional applications requires knowledge and a great deal of teacher preparation and practice. When teachers limit computer use to drill and practice, it may be a sign that advanced teaching models are not understood or practiced in the classroom. This has serious implications for staff development programs. Most experienced teachers learn models of teaching through the use of five major training components: 1) reading or listening to the theory of the model; 2) viewing

a demonstration of the model; 3) practicing the model under simulated conditions; 4) receiving feedback about performance; and 5) collegial coaching for application. These components, identified by Joyce and Showers (1980) require considerable time and effort. While most teachers learn models of teaching easily, the time investment required is often underestimated.

Curriculum Integration

Although the experienced teacher may be accomplished in the integration of instruction, utilizing this tool for the integration of curriculum will pose a challenge. Again the teacher will require collegial assistance in the form of feedback and coaching. The teacher will need both material support for software and vision concerning multiple applications and activities.

Teacher Support

Teachers need financial support for the purchase of approrpiate software and hardware. But more than financial support , if the microcomputer is to be used effectively, teachers need collegial assistance: to learn teaching strategies, to deal with the integration of the computer as an instructional tool, and to anticipate the changes in the classroom environment that need to occur. The findings relating microcomputer-based instruction in self-contained classrooms by elementary level teachers of grades K-6 surely indicate that staff development needs to be planned not as a time-limited experience but rather as collegial professional development over the course of several semesters.

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